Btev Straw Detector – General considerations for integration

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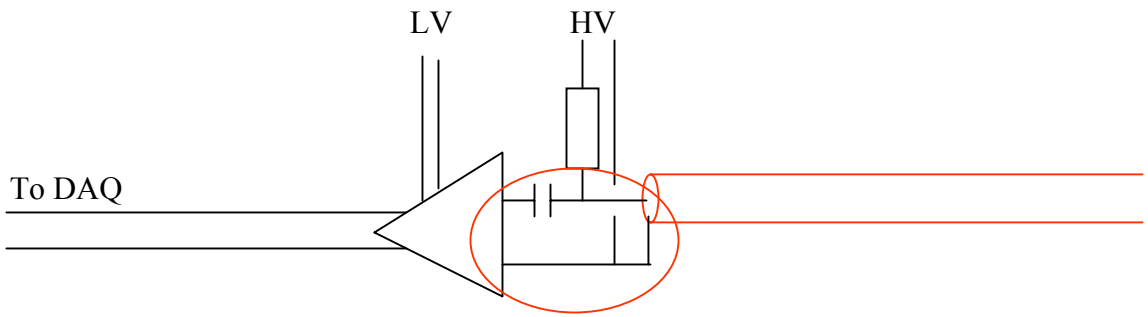
- Grounding
- Low Voltage Distribution
- High Voltage Distribution
- System Integration
- Conclusions

Signal



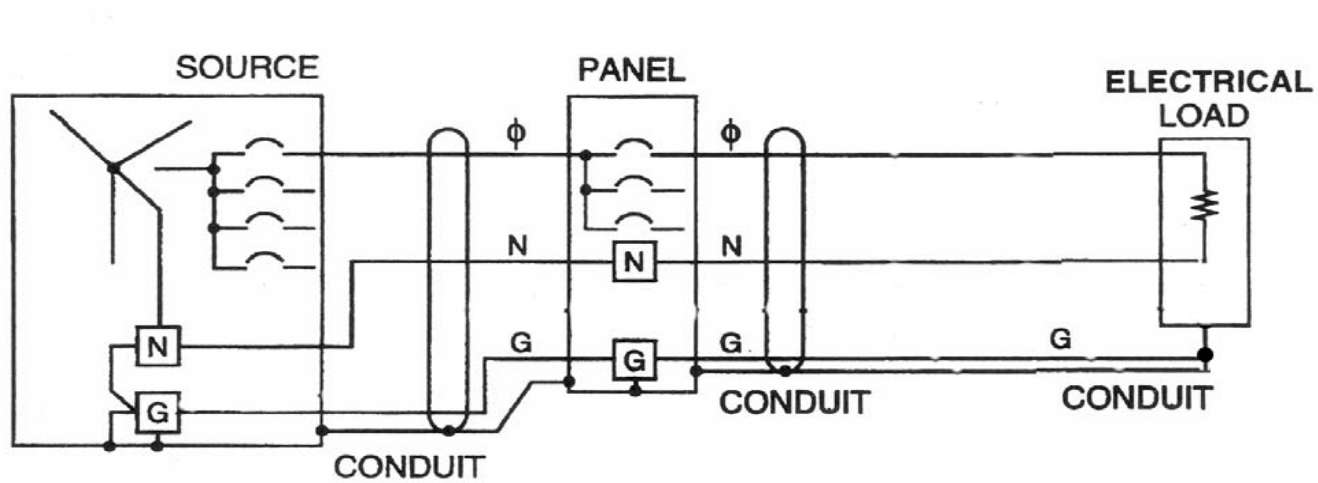
- Critical areas for noise
  - Signal connection at input of the amplifier
  - External part of the straw

Grounding

- Reasons for Grounding
  - Personal safety
  - Equipment protection
  - Performance
- In HEP experiments the system can separated in two areas
  - The AC distribution area
    - Voltage 110-208-440V, High short circuit current (5-10 times the nominal value)
  - The DC distribution area
    - Extra-low voltage (<10V), high currents less than 60A
    - High voltage (.5KV-15KV), tinny currents

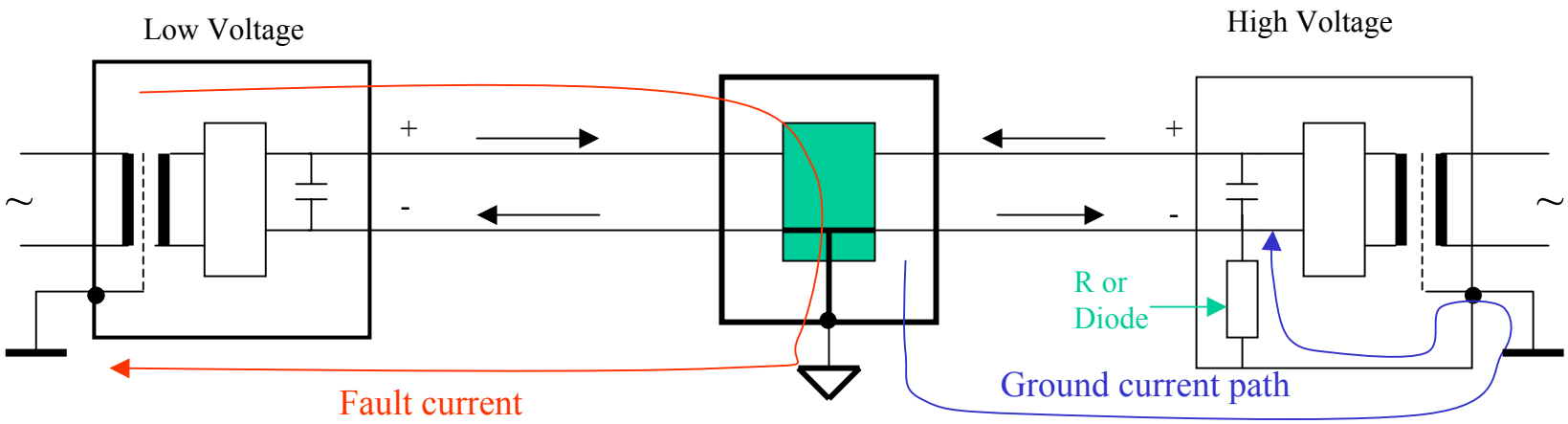
Grounding

- Basic grounding or earthing rules
  - Grounding is not required for correct operation of the system.
  - No current returns should use reference/safety grounds
  - No safety violations should be allowed to improve performance.
  - In large experiments a (a few) person should be assigned to design the general grounding and not a person per sub-detector.
- AC distribution area: Standard Ground Configuration



Grounding

- The DC distribution area
  - Low voltage / High current ----- Fire Hazard
  - High voltage / Tinny current ----- Personal injury / death
    - Partial destruction of electronics parts
  - Front - end electronics (Load) power terminal is in general connected to the metallic box or case



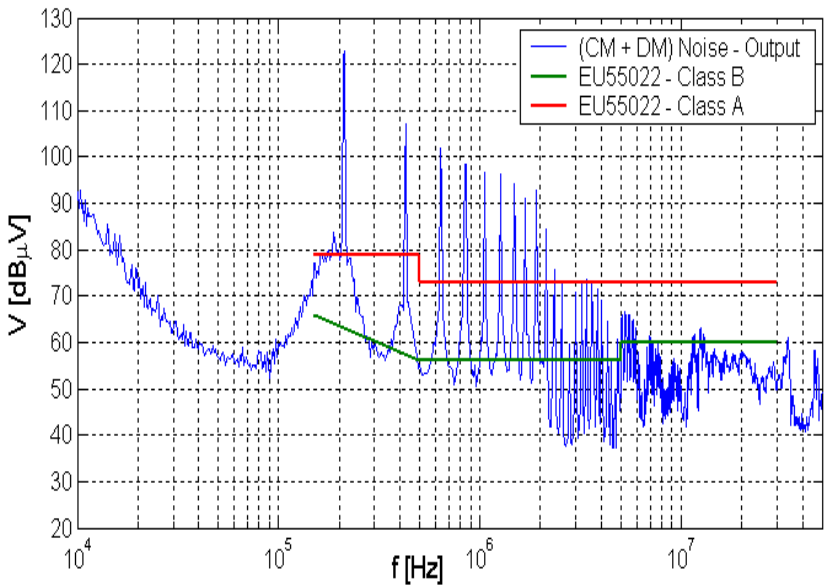
Low-Voltage Distribution

- Power supply location
  - Close – Reduced cable volume / Better transient performance/ Better granularity (?) / Radiation area / Maintenance.
  - Far-away – Away from radiation area / Easy access / Long power cables / transients and protections.
  - Defines: Voltage/Current specs, Cooling system, MTBF, Auxiliary systems, etc.
- Linear vs Switching converters (SMPS).
  - Defines: Noise specifications (Linear : ripple, SMPS : ripple + common mode noise at input and output, radiation noise), transient specifications.

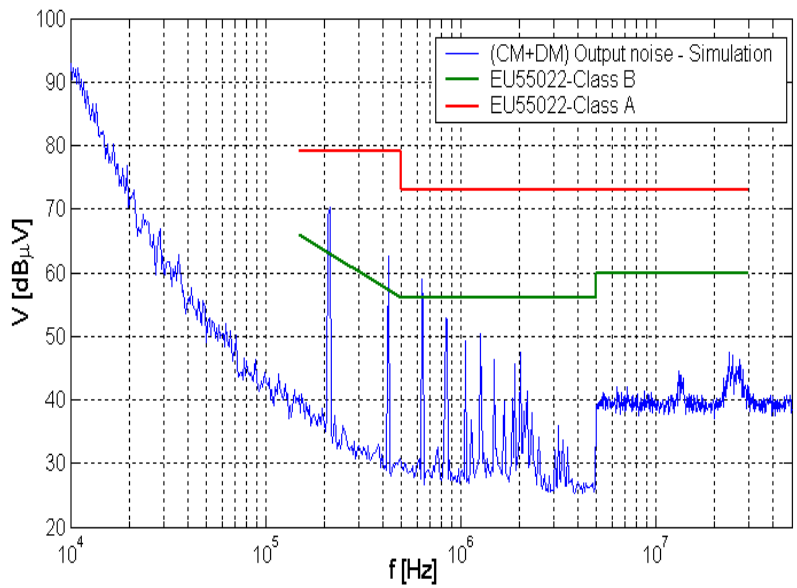
Low-Voltage Distribution

- FCC and EU Standards specify the noise at the power converter input. No commercial standard for the output
- Noise measures at the output DC-DC converters
  - Vicor DC-DC converter 7.5V/15A

- Output noise without filter



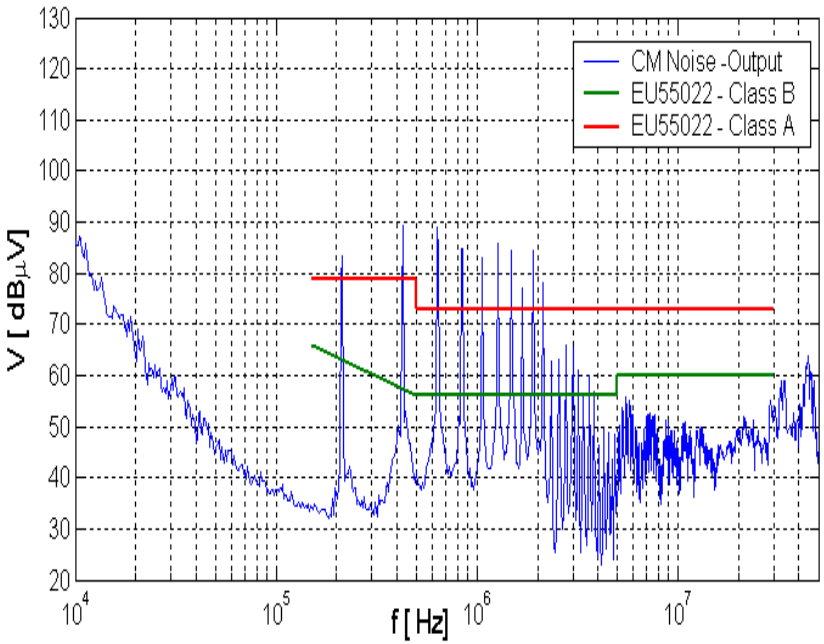
Output noise with filter



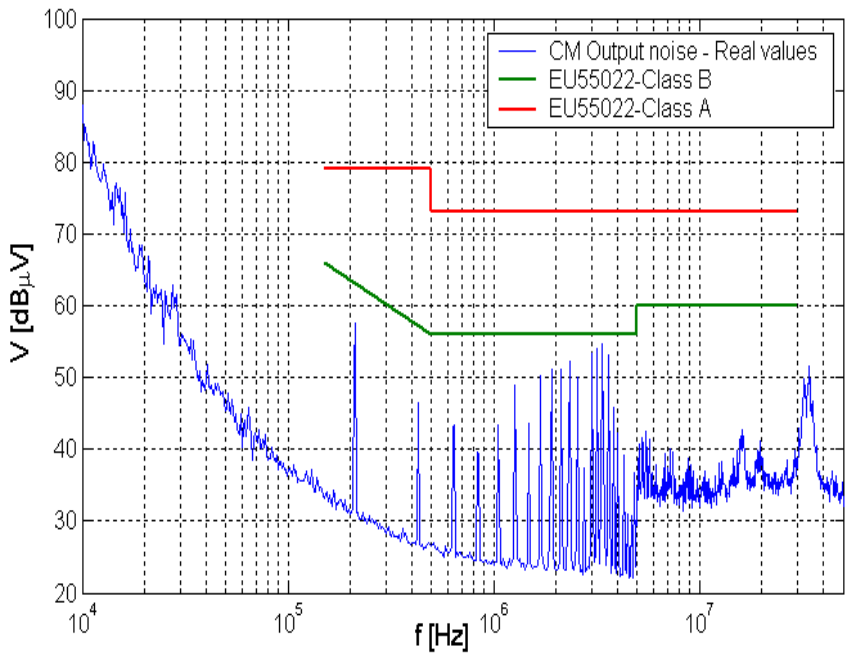
Low Voltage Distribution

- Output CM noise

- Output CM noise without filter

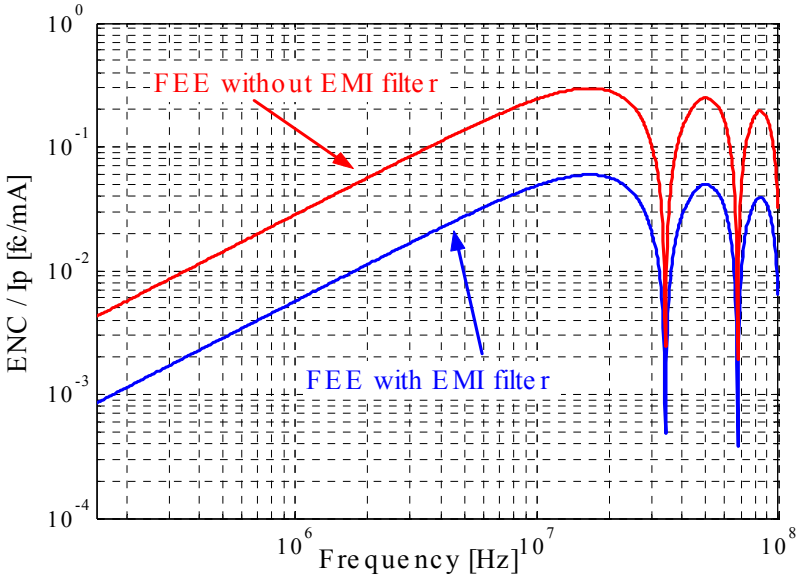


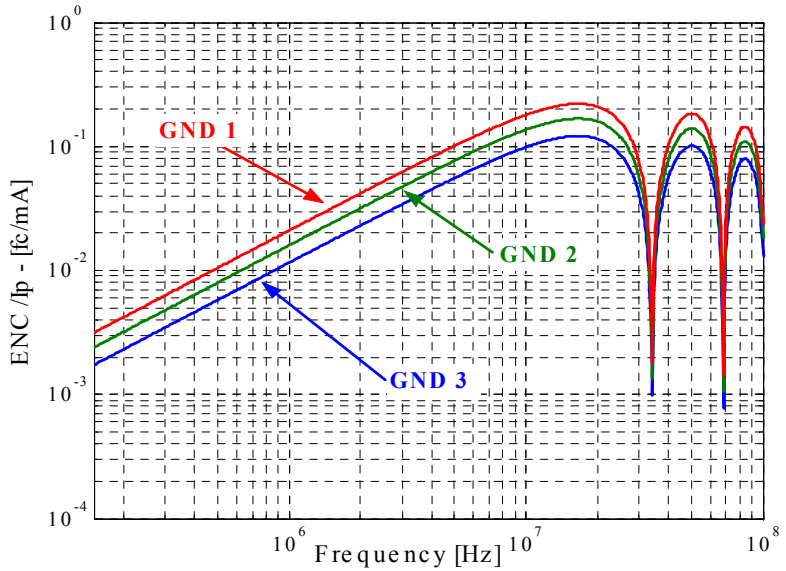
Output CM noise with filter



Low Voltage Distribution

- Effect of SMPS on CMS HCAL front-end electronics





Output of FEE - fC	**FEE - I**	**FEE - II**	**FEE - III**
PS – No Filter	3.1	5	14.6
PS + EMI Filter 1	1.02	1.12	1.94
PS + EMI Filter 2	0.97	0.98	1.09

GND3-***FEE I***, GND1-***FEE II*** and FEE without input EMI filter-***FEE III***).

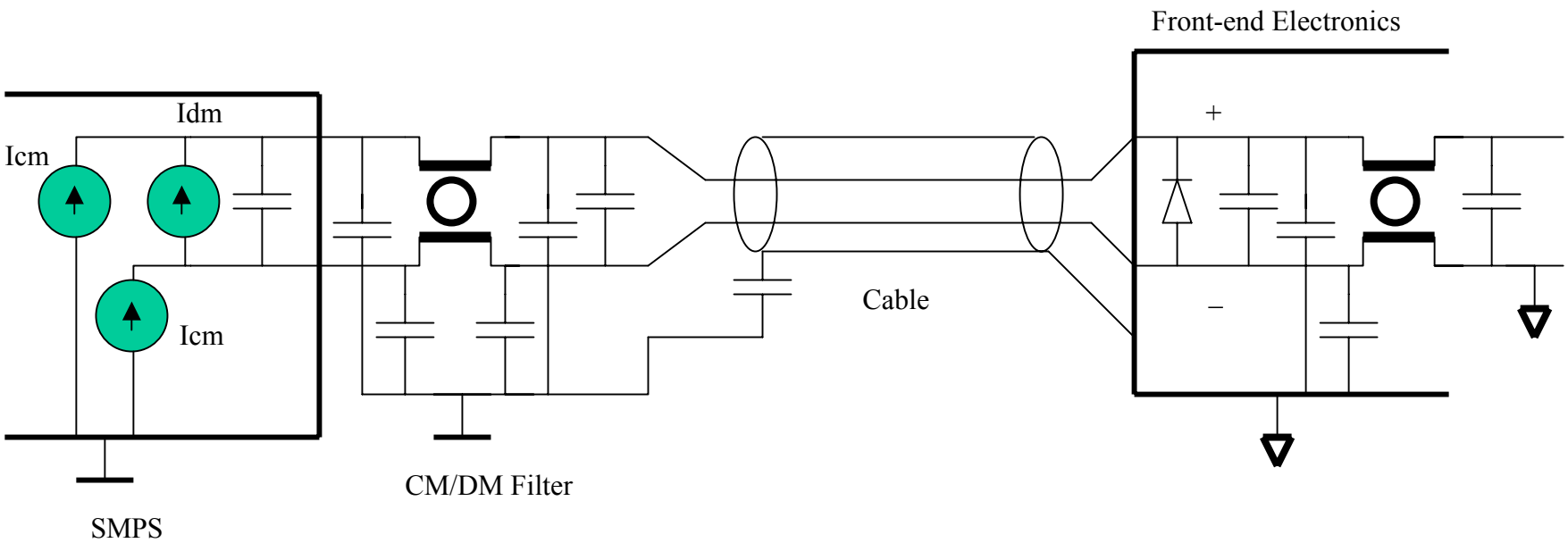
All tests performed with Fernando Arteche CMS CERN

Low Voltage Distribution

- Noise at the output should pass FCC or EU-ClassB
  - Custom/Semi-custom power supply
  - Option 1 - Wienner-CAEN providers (Minos uses Wienner power supplies wit similar characteristics to the depicted above)
  - Option 2 - Commercial units + Filters + Integration
  - Costs: about the same ~ 3$/W
    - Wienner includes monitoring system + ‘commercial unit’.
    - Option 2 assumes integration outside Fermilab.

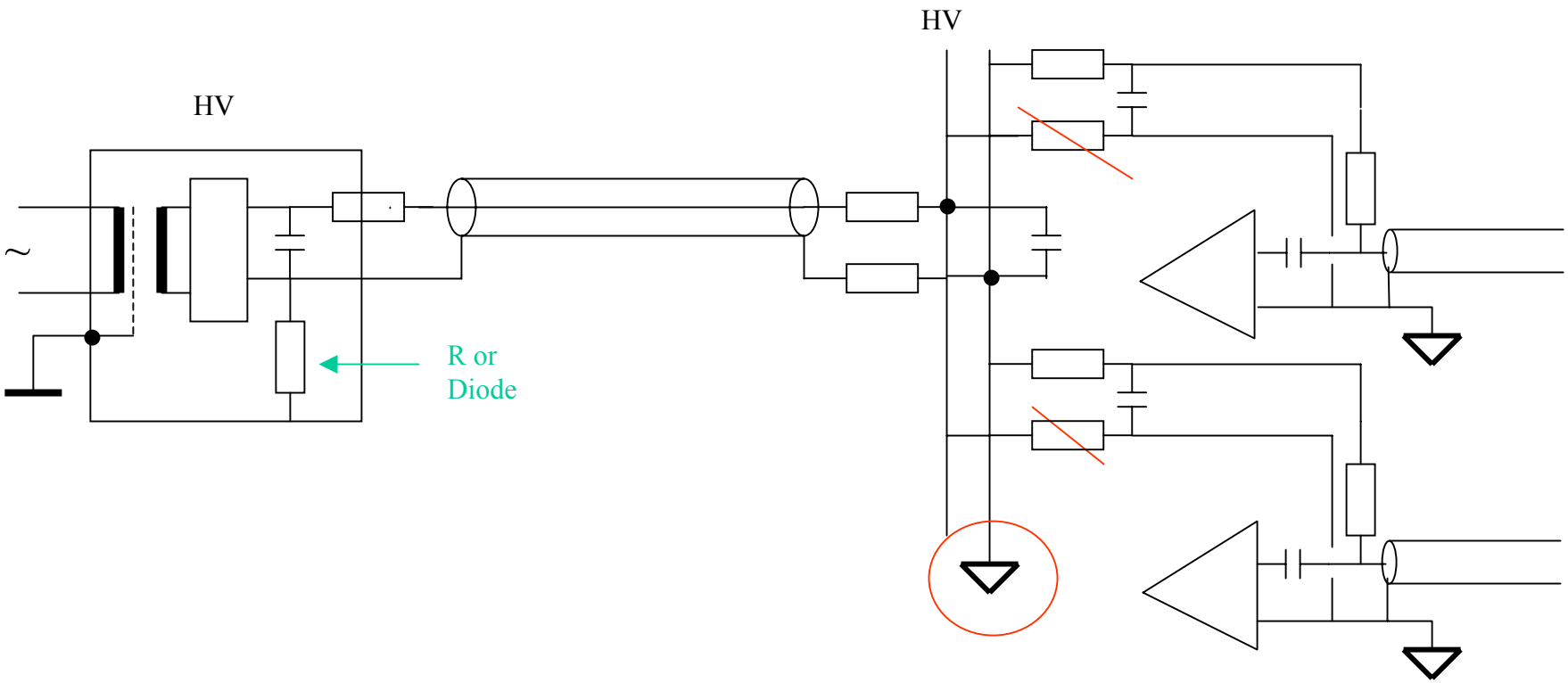
Low Voltage Distribution

- LV connection



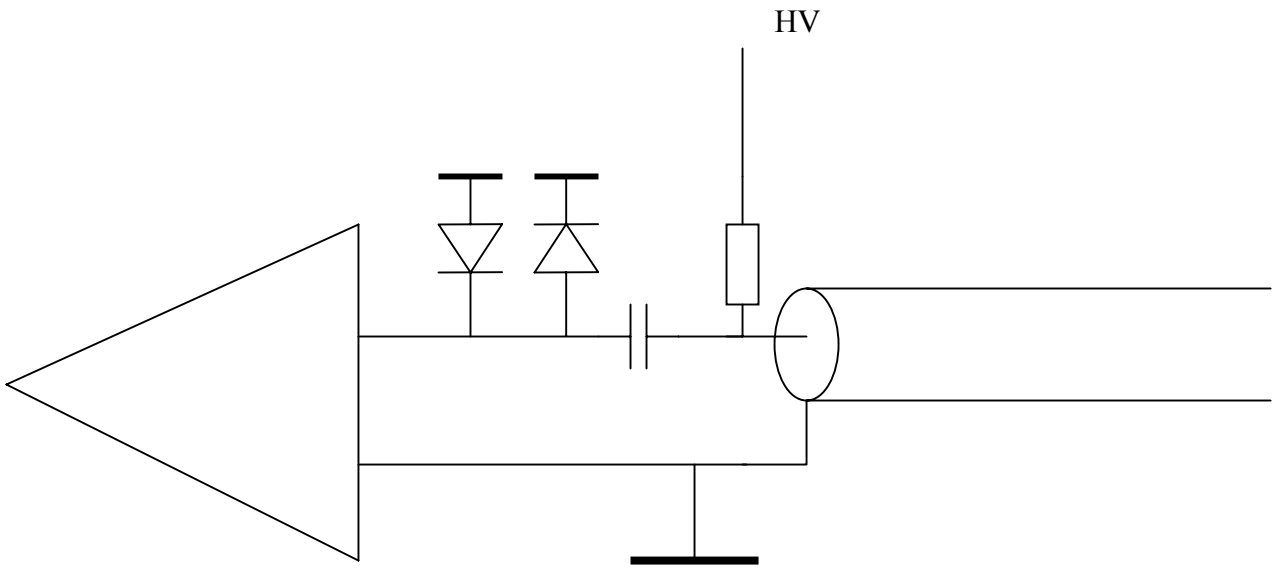
High Voltage Distribution

- Location: Far-away, power is distributed by long cables



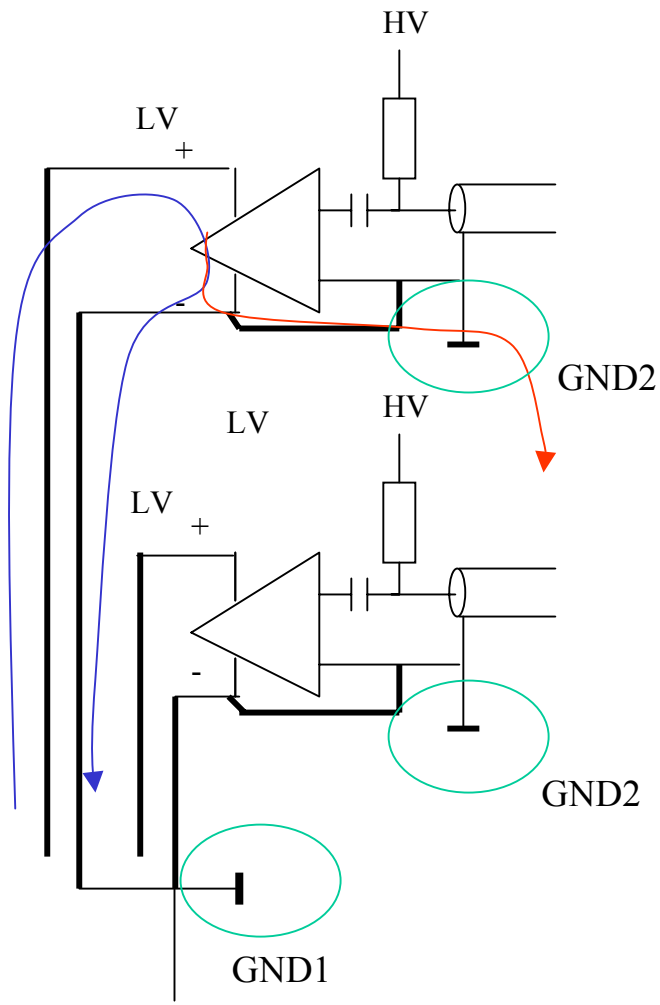
High Voltage Distribution

- Protection



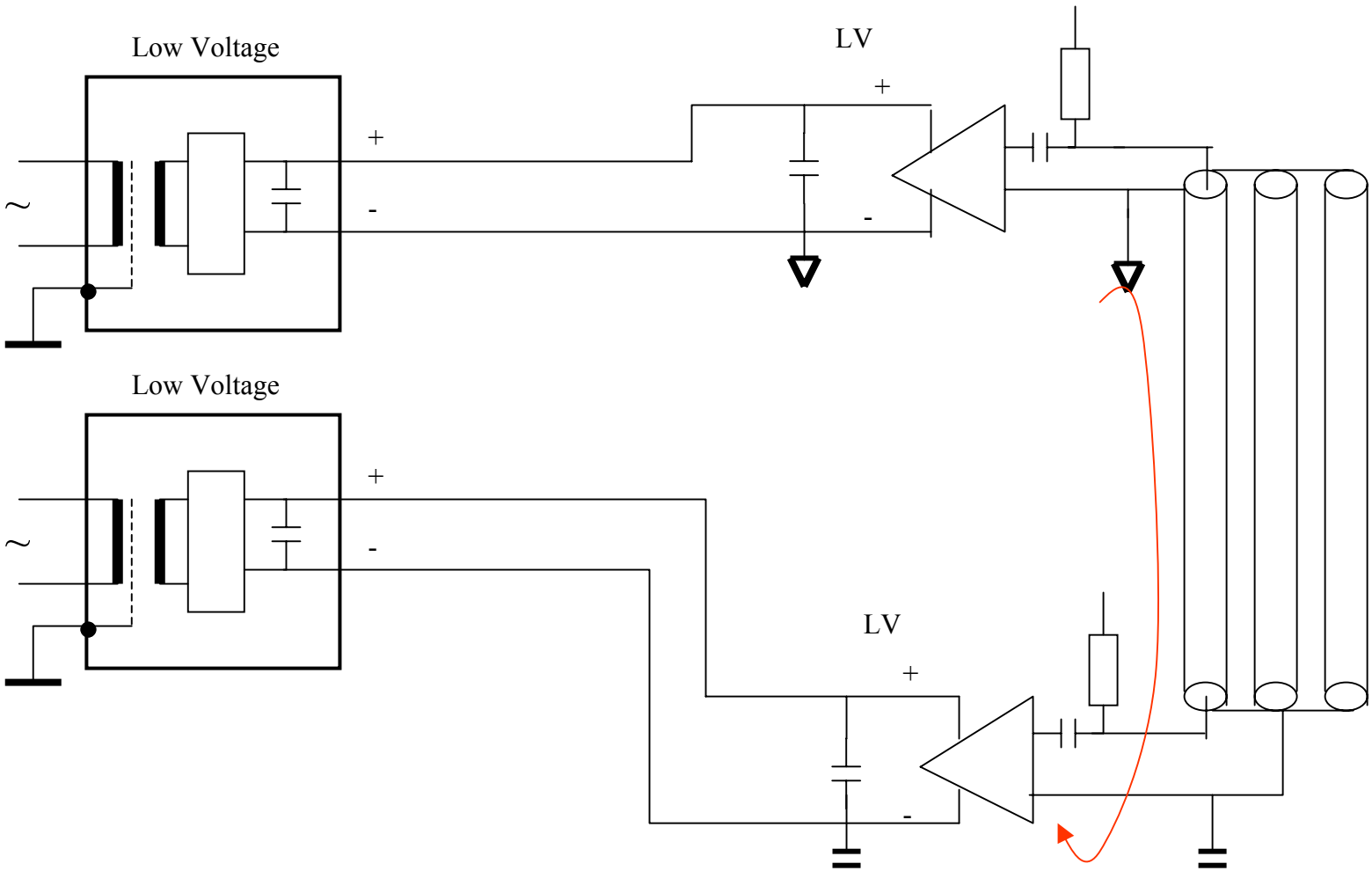
System Integration

- LV-HV connections – Modules
- Typical ground loop due in front-end modules
  - Detector device: single ended
  - Power distribution grounded at the input terminal
  - Front-end electronics: grounded at input (due to the straw)
- Safety: GND1
- Performance:GND2
- Ground loop at low frequency involves the inputs



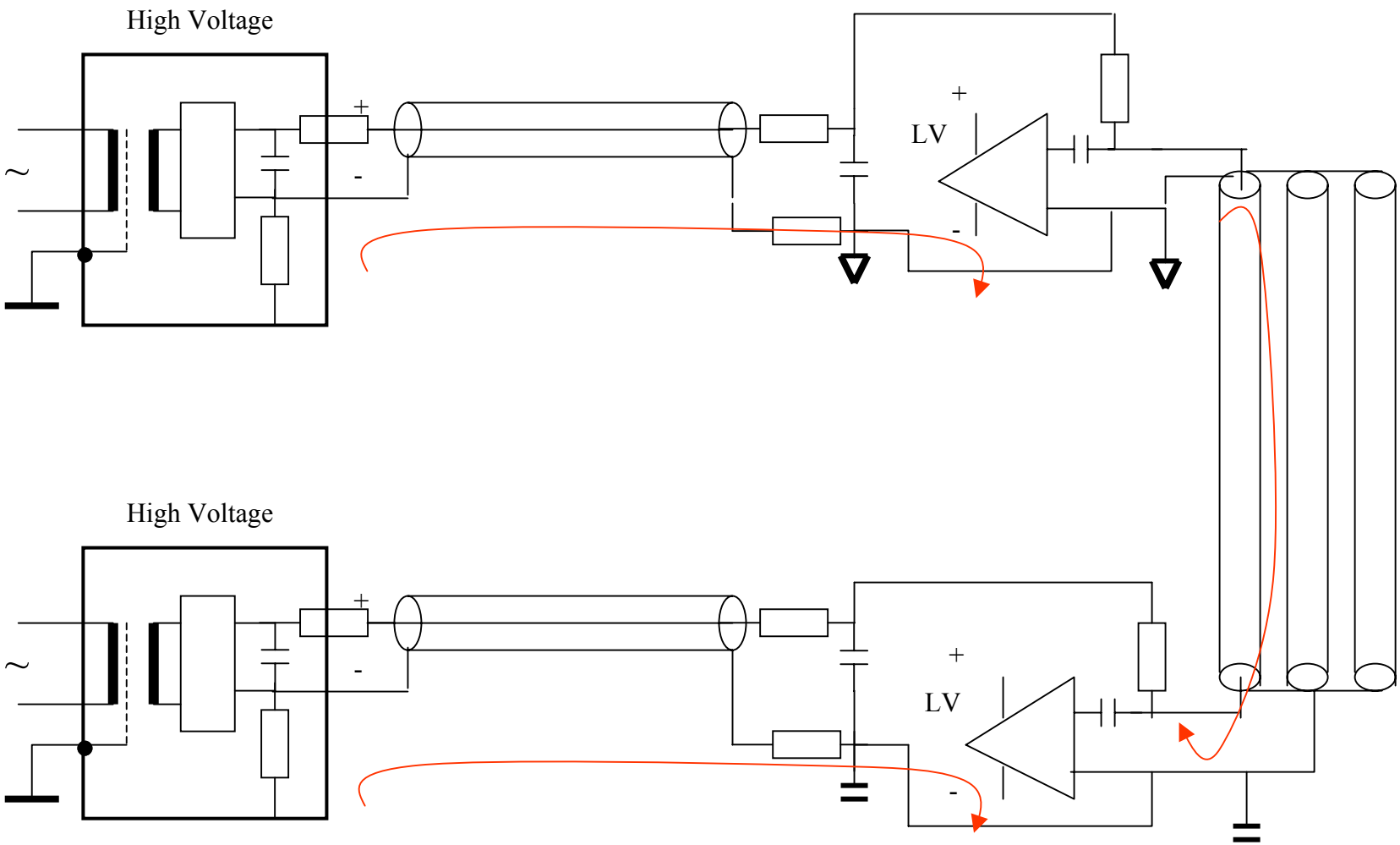
System Integration

- LV connections- Full Straw



System Integration

- HV connection – Full Straw



Conclusions

- Understanding and including in the design of the FEE integration problems as LV-HV power distribution and grounding problem it is a very good starting.
- It should be assigned a a person to coordinate the overall grounding of the detector,
  - At each sub-detector a person with analog experience and interacting with the 'grounding coordinator' is probably enough.
  - Written grounding polices for the complete detector helps but
    - if the policy is a bunch of receipts copied from previous experiments or books, it does not help.
    - The policy can not replace the lack of knowledge about grounding or electromagnetic compatibility issues
  - If a person takes 1 week to define granularity of power supplies, design distribution cables and write appropriated specification for buying the power supplies, it will take 2-3 weeks to design the grounding of the sub-detector.